REMARKS

Claims 2 and 5 have been rejected under 35 USC 102(b) as being anticipated by Hayes (U.S. Patent No. 6,077,380). Claim 4 has been rejected under 35 USC 103(1) as being unpatentable over Hayes in view of Kuramoto (U.S. Patent Publication No. 2001/0020744).

Amended independent claim 5 is directed to a microelectromechanical device of at least two components, wherein at least one component comprises two substrates with thermoelectric material arranged on the substrates which are joined together by solder. These features are disclosed in paragraphs 0064-0066, 0071, and 0072, and in Figures 6 a, 6b, and 7.

Amended dependent claim 6 recites that the thermoelectric material is arranged as a Peltier cooler or a thermoelectric transducer.

New dependent claim 22 recites that at least one component has one of an electrical, a thermal, and a bonding functionality. These features are disclosed in original claim 5 and in paragraph 0015.

Hayes describes solid spheres coated with a low melting material and a method of forming those spheres. The spheres are used, for example, as a solder for joining arrays. The coated spheres are formed by merging droplets of two different materials where the lower melting material is deposited as a coating on a droplet of the higher melting material. Preferred materials are copper as the high melting material and a solder, e.g. bismuth or gold, as the low melting material. This process leads to the formation of spheres coated with a solder. The spheres might be used for joining substrates, in microelectronical devices for example (see Fig. 6).

Amended claim 5, on the other hand, is directed to a microelectromechanical device comprising at least two components, whereby at least one of the components has two substrates joined by a solder. A thermoelectric material is arranged on each of the substrates. Furthermore, as recited in claim 6, the thermoelectric material is in the form of a Peltier element or a thermoelectric transducer.

The device according to amended claim 5 has a complex, layered construction. At least two substrates with thermoelectric material are joined by the action of a eutectic mixture of gold and bismuth to one component, which is then joined using the same solder to at least one other component, thereby forming a multilayered device.

For example, the component having the thermoelectric material can be used as a cooling device which can be bonded to a laser chip or laser diode. Hence, the device according to amended claims 5 provides a thermoelectric element which can be joined in a very simple manner to another electrical or thermal device as the second component. Due to the use of a eutectic bismuth-gold mixture, the device can be assembled at low temperatures (below 271°C). This allows for a gentle and simplified production of the complex microelectromechanical device.

Furthermore, it is known that the composition of multicomponent devices changes over time as a result of preferential sputtering of different elements. This effect can be avoided or reduced by using the eutectic Bi-Au-mixture.

The device as depicted in Figure 6 of Hayes merely shows a microelectronical device joined to a substrate through solder-coated spheres, and does not provide any further information about the microelectronical device. Hayes also does not suggest the use of thermoelectric material for forming a thermoelectric device, and combining the device with another thermal or electrical device.

Kuramoto relates to a method of forming a solder film on a metallic surface. This is achieved by depositing tacky substrates such as benzotriazole or imidazol derivatives on the metallic surface followed by applying the solder. The solder is then molten under formation of thin solder film. Examples of solders are eutectic bismuth alloys, as disclosed in paragraphs 0063-0065. The solder particles have sizes of 1 to 500 μm (see paragraph 0062). The formed solder film has a thickness of between 5 and 200 μm (see claims 1 and 4).

However, Hayes, either alone or in combination with Kuramoto, does not suggest to one of ordinary skill in the art an electromechanical device, let alone a device comprising at least two components as described in amended claim 5.

Hayes and Kuramoto teach the use of an Au-Bi-alloy as a solder. Hayes further discloses the application of such a solder for joining substrates in microelectronical devices. However, neither of these references suggests applying an Au-Bi-solder when assembling substrates with thermoelectric material to one component, which is further joined with a second component. This second component could be a laser diode circuit, heat sink, sensor, or an optoelectronic device forming a complex multilayered microelectromechanical device.

Claims 5-12 and 22are therefore patentable over the applied references.

In view of the above, Applicant believes the pending application is in condition for allowance.

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Respectfully submitted,

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